

Western Electric Co., Incorporated,
Engineering Dept.,
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(2 Pages) Page #1.
Appendix #1.
Issue 4 - BT-431225.
Replacing all previous issues.
February 18, 1922.

METHOD OF OPERATION
FINAL SELECTOR CIRCUIT.

With Marginal Test-Arranged For Routine Subscriber's Line Testing-Full
Mechanical Switching System.

Page 8. - The circuit requirements have been changed to read as follows:

THE READJUST REQUIREMENTS SHOWN BELOW ARE FOR MAINTENANCE USE ONLY

	<u>OPERATE</u>	<u>NON-OPERATE</u>	<u>RELEASE</u>
E 527	Special requirements to insure fast release.		
(L)	Readj. .015 amp.	Readj. .010 amp.	Hold:
Inner	Test .016 amp.	Test .0095 amp.	Readj. .011 amp.
Wdg.	W.C.C. .0185 amp.		Test .012 amp.
(1000 ohms).			W.C.C. .013 amp.
Outer	Test .041 amp.		
Wdg.	W.C.C. .086 amp.		
(500 ohms).			
E547	Special requirements to insure fast release.		
(T)	Readj. .048 amp.	Readj. .039 amp.	
Outer	Test .051 amp.	Test .037 amp.	
Wdg.	W.C.C. .107 amp.	W.C.C. .017 amp.	
(400 ohms.)			
Inner	Test .016 amp.		Test .0036 amp.
Wdg.	W.C.C. .048 amp.		
(900 ohms).			

NOTE: 1:- This relay shall be equipped with a removable
Armature stop (Piece part 163914).

Spl.E9	Special requirements to meet circuit conditions.	
D20876	Armature travel .020" \pm .0025".	
Coded	Readj. .0254 amp.	Readj. .0215 amp.
E551	Test .0268 amp.	Test .0205 amp.
(P.B.X.)	W.C.C. .0268 amp.	W.C.C. .0164 amp.

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METHOD OF OPERATION SCHEMATIC

For - Final Selector Circuit - With Marginal Test Arranged For - Routing Subscriber's
Line Testing - Full Mechanical Switching System -

GENERAL DESCRIPTION

1. This circuit is used in a full mechanical office, for establishing connections between the originating subscriber and the terminating subscriber or P.B.X. line, and is selected by either a local, cordless or an interoffice incoming selector. This circuit may also be used with a portable or permanent subscriber's line test set for the purpose of establishing connections between the test set and any line within its range, or to select any or all of the lines in a bank, step-by-step under the control of the test set.

2. The principal functions of this circuit are as follows:-

- (1) To select the called line and establish talking connection.
- (2) To test the line for busy.
- (3) To hold it busy to other hunting selectors while in use.
- (4) To give a busy back signal to the calling subscriber or operator when the desired line is busy.
- (5) To select a non-busy line in a P.B.X. group.
- (6) To provide means whereby a line test set may be used for routine testing of lines.

DETAILED DESCRIPTION

OPERATION

REGULAR CALLS

3. When an incoming selector connects to the tip, ring and sleeve terminals of this circuit, ground is connected to the sleeve terminal through the associated incoming circuit thus making this circuit test busy to other hunting incoming selectors, and the fundamental circuit is closed operating the L relay. The fundamental circuit is traced from battery through the inner winding of the L relay, lower inner contact of cam G, and the upper inner contact of cam F, over the tip side of the circuit, through the associated incoming circuit and the stepping relay in the sender circuit (not shown), back to ground in the associated incoming circuit. The L relay, operated (a) locks in a circuit from battery through its inner winding and make contact, lower outer contact of cam G, and upper inner contact of cam F, thence over the fundamental circuit to ground in the associated incoming circuit, and (b) closes a circuit from ground on its armature, through the lower inner contacts of cam E and D and winding of the TK relay to battery.

The TK relay operates in this circuit and locks in a circuit from battery through its winding and make contact to ground on the sleeve of the associated incoming circuit. The TK relay operated, closes a circuit from ground on its armature, through the upper outer contact of cam C to battery through the R magnet, advancing the switch to position 2.

4. In position 2 a circuit is closed from ground on the armature of the L relay, through the inner contacts of cam E, to battery through the high speed (HS) magnet, causing the selector to move upward for brush selection. As the selector moves upward, carrying the commutator brushes over the commutator segments, the A segments and brush intermittently connect ground to the tip side of the fundamental circuit through the lower outer contact of cam F, holding the L relay operated, but successively short circuiting the stepping relay in the associated sender circuit, thus releasing and permitting the re-operation of the stepping relay until sufficient impulses have been sent back to satisfy the sender. The fundamental circuit is then opened by the sender releasing the L relay. The L relay released, opens the circuit through the high speed magnet, thus stopping the upward movement of the selector, and closes a circuit from ground on its armature through the upper outer contact of cam B to battery through the R magnet advancing the switch to position 3. With the switch in position 3 the trip magnet (TM) operates in a circuit from battery through its winding to ground through the upper outer contacts of cam I.

5. In position 3, the L relay re-operates and locks in the fundamental circuit, closing a circuit from ground on its armature, through the upper inner contact of cam B, to battery through the R magnet advancing the switch to position 4. In position 4, the HIGH SPEED magnet is again energized causing the selector to move upward for tens selection. The TRIP magnet being operated in position 3 to 5, the previously selected set of brushes is tripped as the selector starts upward in position 4. As the selector moves upward, carrying the brushes over the commutator segments, the B segment and brush intermittently connect ground to the tip side of the fundamental circuit, through the upper outer contact of cam G, holding the L relay operated, but successively short circuiting the stepping relay in the associated sender circuit, thus releasing and permitting the re-operation of the stepping relay until sufficient pulses have been sent back to satisfy the sender. The fundamental circuit is then opened by the sender, releasing the L relay. The release of the L relay, closes a circuit through the R magnet which advances the switch to position 5. In position 5, the L relay again operates and locks in the fundamental circuit, closing a circuit from ground on its armature to battery through the R magnet, advancing the switch to position 6.

6. In position 6, the low speed (LS) magnet is energized in a circuit from battery through its winding, upper inner contact of cam D, and lower inner contact of cam E, to ground on the armature of the L relay, causing the selector to move upward for units selection. As the selector moves upward carrying the brushes over the commutator segment, the U commutator brush and segments intermittently connect ground to the tip side of the fundamental circuit through the lower outer contact of cam F, holding the L relay operated but successively short circuiting the stepping relay in the associated sender circuit, thus releasing and permitting the re-operation of the stepping relay until sufficient pulses have been sent back to satisfy the sender. The fundamental circuit is then opened by the sender releasing the L relay. The L relay, released, opens the circuit through

the LS magnet stopping the upward movement of the selector, and closes a circuit from ground on its armature, through the contact of the T-1 jack, and lower contacts of cam P, advancing the switch to position 7. In position 7, the L relay again operates and locks in the fundamental circuit, advancing the switch to position 8, the A cam carrying the switch to position 9. When the switch advances beyond position 7-1/2 the L relay is held operated in a circuit from battery through its inner winding and make contact to ground on cam I. In position 9, the T relay operates in a circuit from battery through the inner contacts of cam I, outer winding of the T relay, lower contacts of cam E, to ground on the armature of the L relay.

INDIVIDUAL LINE, OR FIRST LINE OF A P.B.X. GROUP NOT BUSY.

7. The T relay, operated in position 9, closes a circuit from ground through the lower inner contact of cam I, through the lower inner contact of cam J, make contact of the T relay, through the lower outer contact of cam B to battery through the R magnet, advancing the switch to position 10, the A cam carrying the switch to position 11. The L relay releases when the switch advances beyond position 9. If the sleeve brush is resting on the sleeve terminal of an idle P.B.X. or individual line when the switch leaves positions 9, the T relay releases. The release of the T relay advances the switch to position 13 in a circuit from ground on cam I, through the lower inner contact of cam J, break contact of the T relay, and lower inner contact of cam B, to battery through the R magnet. The A cam advances the switch to position 14. In position 14, a circuit is closed from ground on the armature of the L relay, to battery through the R magnet, advancing the switch to position 15, (talking position). The release of the T relay in position 9 also connects battery through the lower contacts of cam K, the 18 Q resistances, break contact of the T relay, lower inner and upper outer contacts of cam L, and sleeve brush to the sleeve terminal of the selected line, thereby making it test busy to any other hunting selector. When the switch enters position 12-3/4, a circuit is closed from ground on cam I, through the lower outer contact of cam H, to operate the selector group register.

DISCONNECTION

8. When the associated incoming selector returns to normal, ground is disconnected from the sleeve terminal, thus releasing the TK relay. The TK relay, released, connects ground through the inner contacts of cam I, break contact of the TK relay, to the sleeve terminal thus holding the selector busy to other hunting incoming selectors until the switch advances to normal, and closes a circuit from ground on its armature, through the lower outer and upper inner contacts of cam N, to battery through the outer winding of the L relay. The L relay operates in this circuit, advances the switch to position 16 and locks provided the receiver at the called station has not been replaced on the switchhook. The locking circuit is traced from battery through its inner winding and make contact through the outer contacts of cam M, R brush and terminal, over the ring side of the called line, through the subscriber's set, back over the tip side of the line, through the T terminal and brush, and lower outer contact of cam J, to ground on cam I. In position 16, the 18-AE resistance is connected through the lower contacts of cam U, in parallel with the inner winding of the L relay. This insures the release of the L relay with a 10,000 ohm leak across the line. In position 16 ground on the armature of the L relay is connected through the lower inner contact of cam E, and the upper outer contact of cam D,

to the (P.S.) selector time alarm circuit, thereby operating an alarm if the switch remains in position 16 for an abnormal length of time. When the receiver is replaced on the switchhook at the called station, the L relay releases, advancing the switch to position 17. In position 17, a circuit is closed from ground on the armature of the TK relay, through the lower outer contact of cam C, to battery through the R magnet, advancing the switch to position 18. The TRIP magnet is operated in position 17 and 18 to guard against the brushes catching on the trip finger on the downward movement. In position 18 a circuit is closed from ground on cam I, through the upper outer contact of cam H, lower outer contact of cam D, and the upper outer contact of cam R, to battery through the DOWN magnet, causing the selector to move downward. When the selector has returned to normal, a circuit is closed from ground through the Y commutator brush and segment, and upper inner contact of cam C, to battery through the R magnet, advancing the switch to position 1.

INDIVIDUAL LINE BUSY

9. If the sleeve brush is resting on the sleeve terminal of a busy individual line, when the switch enters position 9, the P.B.X. and TB relays operate, in a circuit from ground through the lower inner contacts of cam I and H, winding of the P.B.X. relay, winding of the TB relay, make contact of the T relay, lower inner and upper outer contacts of cam L, and S brush, to battery on the sleeve terminal of the busy individual line. The T relay holds in a circuit through its inner winding to ground on the armature of the TB relay, advancing the switch to position 10, the A cam advancing it to position 11. When the switch advances beyond position 9, the L relay releases. In position 11, a circuit is closed from ground on the armature of the L relay, to battery through the R magnet advancing the switch to position 12. In position 12, a circuit is closed from ground through the lower inner contacts of cams I and J, make contact of the T relay, lower inner contacts of cams F and G, to battery through the inner winding of the L relay. The L relay operates in this circuit and locks in a circuit from battery through its inner winding and make contact, to ground on cam I, advancing the switch to position 13. The A cam advances the switch to position 14. In position 14, a circuit is closed from ground on the armature of the L relay, through the lower inner and the upper outer contacts of cam E, to battery through the DOWN magnet, causing this selector to move downward. When the selector reaches normal ground on the Y commutator brush and segment is connected to the R magnet through the upper inner contact of cam C, advancing the switch to position 17. When the switch advances the L relay releases, thereby releasing the DOWN magnet and the T and TB relays release. In position 17 a circuit is closed from ground through the contacts of the busy back interrupter, through the inner contacts of cam O, outer winding of the T relay and inner contacts of cam K, to battery, alternately operating and releasing the T relay. The operation of the T relay closes a circuit from the busy back tone circuit, through the 19-AN resistance, lower contacts of cam L, make contact of the T relay, inner contacts of cam M, over the ring side of the trunk end through the winding of the repeating coil in the associated incoming selector circuit to ground, giving a busy tone to the calling subscriber. A circuit is also closed from battery through the lower inner and upper outer contacts of cam K, 18-AT resistance, make contact of the T relay, through the inner contacts of cam F, over the tip side of the trunk, winding of the supervisory relay (when provided) and repeating coil in the associated incoming selector circuit, to ground, causing the supervisory relay to operate and release as controlled by the T relay. When the calling subscriber

or operator disconnects, the associated incoming selector returns to normal, releasing the TK relay. The release of the TK relay advances the switch to position 18. From this point on, the circuit functions as described under "Disconnection".

FIRST BUT NOT ALL LINES OF A P.B.X. GROUP BUSY.

10. If the sleeve brush is resting on the sleeve terminal of a busy P.B.X. line other than the last in the group when the switch enters position 9, the TB relay operates in a circuit from ground through the lower inner contacts of cam I and H, windings of the P.B.X. and TB relays, make contact of the T relay, lower inner and upper outer contacts of cam L and S brush, to battery on the sleeve terminal of the busy P.B.X. line. The TB relay operated closes the holding circuit through the inner winding of the T relay. The P.B.X. relay does not operate at this time due to the high resistance of the busy P.B.X. sleeve circuit. The B relay operated, advances the switch to position 10, the A cam advancing it to position 11. The L relay releases when the switch advances beyond position 9. In position 11 the L relay re-operates in a circuit from ground through the lower inner contacts of cams I and J, make contact of the T relay, break contact of the P.B.X. relay, inner contacts of cam G, to battery through the inner winding of the L relay. The L relay operated, closes a circuit from ground on its armature, to battery through the LOW SPEED magnet causing the selector to move upward and hunt for an idle P.B.X. line. When an idle line is found the TB relay releases and the holding circuit through the inner winding of the T relay is opened, but the T relay does not release immediately due to a circuit being closed from ground through the C commutator brush and segment, upper outer and lower inner contacts of cam O, outer winding of the T relay, inner contacts of cam N, to battery through the outer winding of the L relay. When the brushes are centered on the idle line terminals, the circuit through the C commutator brush and segment is opened, and the T relay releases, in turn releasing the L relay. The release of the L relay advances the switch to position 12, and opens the circuit through the LOW SPEED magnet, stopping the upward movement of the selector. In position 12 a circuit is closed from ground through the lower inner contacts of cams I and J, break contact of the T relay, lower inner contacts of cam B, to battery through the R magnet, advancing the switch to position 13, the A cam advancing the switch to position 14. From this point on the circuit functions as described under "Individual Line or first line of a P.B.X. group not busy".

NOTE:- The adjustment of the C commutator brush, with relation to the tripped sleeve multiple brush, is such that it does not break contact with the C commutator segment until slightly after the holding circuit through the inner winding of the L relay is opened by the sleeve brush leaving the busy terminal and is making contact with the sleeve terminal of the idle line. The LS magnet remains operated and the selector continues to move upward until the brushes are carried slightly above the center of the idle line terminals, allowing the locking pawl to enter the notch on the rack attached to the brush support rod. At this time the holding circuit through the outer winding of the T relay is opened at the C commutator, releasing the T relay. The T relay, released, opens the holding circuit through the inner winding of the L relay. The L relay releases disconnecting ground from the commutator feed bar G, and releasing the LS magnet. The selector then drops into place, thus centering the brushes on the line

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NOTE:- terminals. During P.B.X. hunting in position 10-3/4 to 11 the commutator feed ground is supplied through cams D and E, from ground in the armature of the L relay, and under control of the T relay. This is to prevent the re-operation of the L relay by the closing of a circuit through the C commutator brush and segment, on the overthrow of the selector or as it drops into place.

ALL P.B.X. LINES OF A GROUP BUSY

11. If all the P.B.X. lines of a group are busy when the selector travels upward in position 11, the P.B.X. relay operates, when the sleeve brush makes contact with the sleeve terminal of the last line of the group as explained under (INDIVIDUAL LINE BUSY), opening the circuit through the winding of the L relay. The L relay releases opening the circuit through the LOW SPEED magnet, thus stopping the upward movement of the selector. The release of the L relay also advances the switch to position 12. From this point on, the circuit functions as described under "INDIVIDUAL LINE BUSY".

ROUTINE TESTING OF SUBSCRIBER'S LINE.

12. When used in connection with a subscriber's line test set jacks T-1 and T-2 are connected to the corresponding jacks in the test set by means of patching cords. The test set supplants the functions of the incoming selector and sender circuits used in completing a call. The final selector is held busy to other selectors during the testing period by ground, connected to the sleeve of jack T-1. The fundamental circuit is closed through cam Q and the tip of jack T-1, instead of cams F and G and the tip of the line, as when used on a (REGULAR CALL). With the above exception, the circuit functions the same under control of the test set, as previously described until the switch reaches position 6. With the switch in position 6, the circuit normally used to advance the switch out of position 6, being open at the T-1 jack spring, prevents the switch from advancing out of "unit selection position". In position 6, the tip, ring and sleeve brushes rest on the terminals of the line to be tested, and battery in the test circuit is connected through the sleeve of the jack T-2 to the sleeve terminal holding the selected line busy. The test circuit is connected to the line through the tip and ring of jack T-2. All the lines in the bank may be tested by the operation of a "stepping" key, in the test set. The operation of this key closes the fundamental circuit through jack T-1, operating the L relay. The L relay operated closes a circuit through the LS magnet which moves the selector up to the terminals of the next line. The fundamental circuit is then opened in the test circuit, releasing the L relay, thus stopping the selector. All the lines may be selected step-by-step. To re-set the selector to test in another group of lines or to restore the circuit to normal, a "disconnect" key in the test set is operated, which opens the holding circuit through the TK relay thus releasing it, advancing the switch to position 14. From this point on the return of the switch to normal takes place as described under "Disconnection".

NO TEST FEATURE.

13. On "no test" calls made over Cordless Incoming Selectors a circuit is closed in position 7 from battery on the ring side of the trunk, through the upper outer and lower inner contacts of cam N, outer winding of the T relay, and upper inner contact of cam J to ground, operating the T relay. The T relay, operated, closes a circuit from battery

through the R magnet, lower outer contact of cam B, make contact of the T relay, to ground on cam J, advancing the switch to position 9. The T relay releases when the switch advances beyond position 8. In position 9 a circuit is closed from battery through the R magnet, and upper outer contact of cam B, to ground on the armature of the L relay advancing the switch to position 12. Since the T relay does not operate in 9 the test of the line selected is omitted and in position 11 P.B.X. hunting is omitted. In position 12 a circuit is closed from battery through the R magnet, lower inner contact of cam B, and break contact of the T relay, to ground on cam J, advancing the switch to position 13. In position 13 a circuit is closed (as in position 9) advancing the switch to position 15.

PREMATURE RELEASE

14. When ground is removed from the sleeve of the incoming circuit at any time before the switch advances from position 14, the TK relay releases, connecting ground through the upper inner contact of cam I to the sleeve lead making the selector busy until the switch returns to normal. The TK relay released, also closes a circuit from ground on its right armature through the lower outer contact of cam C, advancing the switch to position 14. Ground on the armature of the L relay advances the switch to position 15. The return to normal from this point on is as described under "Disconnection".

TELL TALE

15. Should the selector travel to the tell tale position during selection in positions 2, 4, 6 or 11 a circuit is closed from ground on the X commutator brush and segment, lower inner contact of cam C, to battery through the R magnet, advancing the switch to position 7 or 12. The switch advances from position 7 or 12 to position 15 as described under "Units Selection" and "Individual line or First line of a P.B.X. Group not Busy". The return to normal from position 15 takes place as described under "Disconnection".

CIRCUIT REQUIREMENTS

	<u>OPERATE</u>	<u>NON-OPERATE</u>	<u>RELEASE</u>
E565 (TK)	Test .019 amp. Readj. .017 amp.	Test .010 amp. Readj. .011 amp.	
E547 (T) Outer Wdg. (400)	Test .049 amp. Readj. .046 amp.	Test .029 amp. Readj. .031 amp.	
Inner Wdg. (900)	Test .016 amp.		
E527 (L) Inner Wdg. (1000)	Test .0165 amp. Readj. .015 amp.	Test .0095 amp. Readj. .010 amp.	
Outer Wdg. (500)	Test .042 amp.		
Spl. L9 D-20876 (P.B.X.) Coded E551	Test .0268 amp. Readj. .0254 amp.	Test .0205 amp. Readj. .0215 amp.	
E1383 (TB)	Test .0065 amp. Readj. .0062 amp.		Test .0009 amp. Readj. .001 amp.

ENG.--ROC-JO.
 7/18/21.

CHK'D.--CHW.

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